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STUDIES ON SPIROBOLOID MILLIPEDS. IV. THE
CHARACTERS AND RELATIONSHIPS OF THE
GENERA *NARCEUS* RAFINESQUE 1820 AND
SPIROBOLUS BRANDT 1833*

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One of the primary reasons for the present unsatisfactory condition of systematics in the Diplopoda is that much of the groundwork was laid by investigators who had little knowledge of, or interest in, certain principles of zoological nomenclature which are now generally regarded as axiomatic. For the most part, the successors of these men have not challenged their authority, and have thus perpetuated the errors. The practice of consulting original literature references has become increasingly neglected.

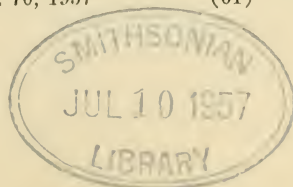
Of the various workers who have, in one way or another, dealt with the family Spirobolidae during the past century, only a few were guided by the basic tenets of nomenclatorial procedure, the majority seeming to follow the courses of their own concern for convenience. As one of the results, the general conception of the Spirobolidae has become founded upon a species not even congeneric with the true type species of *Spirobolus*! By sheer good luck, it happens that this "generotype by usurpation" does belong to the same family as *Spirobolus*, otherwise the ensuing confusion would have been far greater than is actually the case.

For almost 100 years, the name *Spirobolus* has been applied to the genus of spiroboloid millipeds occurring in eastern North America, although Cook pointed out the error of such an association in 1904. With the recent discovery of a valid generic name—13 years older than *Spirobolus*—for the Nearctic species, it became obvious that finally something would have to be done about clearing up the Chaos. I believe that it is now possible to do so, and offer the following resolution of the matter.

HISTORICAL SUMMARY

Spirobolus was proposed in 1833 by J. F. Brandt for two new species, *S. Olfersii* from Brasil and *S. Bungii* from China. No type was design-

*Previous papers under this general heading have appeared in these *Proceedings*, as follows: I. vol. 66, pp. 179-183, 1953; II. vol. 68, pp. 31-36, 1955; III. vol. 68, pp. 151-154.



nated, and although no specifically diagnostic characters (such as male genitalia) were stipulated for either species, enough information was given that, with a consideration of the localities cited, it should have been possible for later workers to identify the genus.

Brandt's immediate successors (such as Gervais) copied his descriptions in their own works, but did not add to our knowledge of either the genus or its two included species. In 1865 the generic name was brought to the North American fauna by Wood, who referred Say's *Julus marginatus* (1821) to the genus. And as *Spirobolus marginatus* this creature eventually became one of the best known of all millipeds. Simultaneously, *bungii* and *olfersii* gradually slipped into obscurity as workers automatically came to think of *Spirobolus* in terms of *marginatus*, its only well-known (*ergo* typical!) species.

Pocock endeavored to bring the matter into its correct perspective in 1894, when he designated *bungii* as the type species of *Spirobolus*. This action, of course, was entirely justifiable, as *bungii* was one of the species originally included in the genus. Pocock described another new spirobolid, *S. walkeri*, from eastern China, and discussed its relationships to the known Chinese species (*bungii* Brandt and *exquisitus* Karsch). Two years later, in 1896, Brolemann added another name, *S. joannisi*, to the roster of species from southeast Asia, so that by 1900 it was known that species considered to belong to *Spirobolus* occurred in both China and North America. That they were regarded as closely related is demonstrated by the opinion of Attems in 1910 that *joannisi* is a synonym of *marginatus*.

The situation was summarized in 1914, in Brolemann's useful *Études sur la Spirobolides*. Brolemann admitted that Pocock had made a valid type designation in selecting *bungii*, but he observed that Brandt's species was still poorly known, and that the American form taken to be *marginatus* might for the sake of convenience be regarded as the entity from which the characters of the genus *Spirobolus* could be inferred. His contemporaries and successors readily embraced this proposal, and *bungii* has not, to the best of my knowledge, been mentioned in the literature for the past forty years.

Shortly after I began the study of diplopods, my colleague H. F. Loomis called my attention to the fact that *Spirobolus* was based on exotic species, and that Cook in 1904 had proposed the name *Arctobolus* for the American forms. But for various reasons no action was taken in this connection until 1953, when, with the discovery of Rafinesque's name *Narceus*, it became apparent that the continued use of *marginatus* as the type of *Spirobolus* would result in the loss of Brandt's generic name as a junior synonym. An investigation was then undertaken regarding the status of the animals involved as well as of the nomenclature affecting them. The decision offered here has been made upon both nomenclatorial and morphological information, and the latter phase will be presented first.

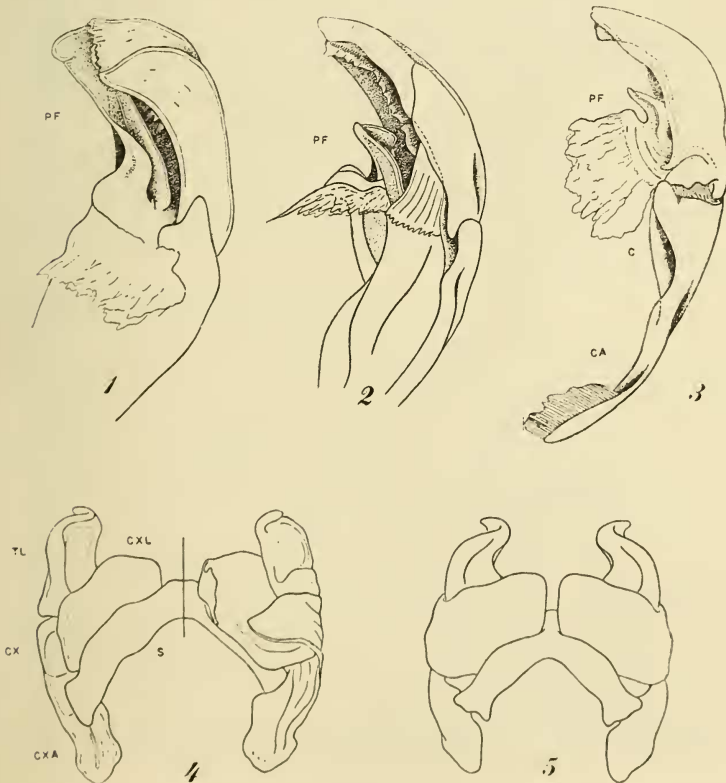
THE IDENTITIES OF THE GENERA *SPIROBOLUS* AND *NARCEUS*

I.

By very good fortune, the United States National Museum contains material of a spiroboloid taken 65 miles north of Peking, China (the

type locality of *bungii*), and these virtual topotypes agree in all important respects with the original description. So far only four large spiroboloid species are known from eastern China, and these are all congeneric. I believe there can be no doubt that the Peking material, if not identical with Brandt's species, is at least very closely related and represents the genus in its strict sense. Until information to the contrary is forthcoming, I shall regard the specimens as belonging to the species *bungii*.

It may be observed from the accompanying figures that the genitalia of this form are very similar to those of the American species. No generic differences whatever can be found in the anterior gonopods, nor have I been able to discover any notable external differences affecting the bodies of the species examined. There is, however, one apparently constant difference involving the posterior gonopods, namely the relative length of the prefemoral process. In *Spirobolus bungii* and its geographically associated relatives, this process is about half the length of the distal joint of the gonopod itself (fig. 3). On the other hand, this process in the American forms is much longer, and equals or exceeds the tip of the telopodite (fig. 1). This distinction, although not par-



ticularly outstanding, is constant in the material I have seen (as well as in literature illustrations) and its utilization as a generic character would seem to be fully justified. In addition to the drawings of the genitalia, I append at this point a brief description of the specimens which I take to represent *bungii*.

Spirobolus bungii Brandt

Figs. 3, 5

Described from a male specimen [USNM] from Tsin Lung Shan, 65 miles north of Peking, China, collected by A. deC. Sowerby.

♂, ca. 80mm. long, 6.0mm. wide, with 55 segments.

Color mostly faded, but enough pigment remains to indicate that in life the animal was dark gray or blackish, with the caudal edge of the segments, the legs, tip of telson, and entire margin of collum yellowish or reddish.

Body stout, about 13 times as long as broad.

Head smooth and evenly convex; epipharyngeal groove distinct as far up as lower edge of antennal sockets; genae slightly swollen, entirely smooth, not margined. Labral setae 8-8, clypeal foveolae 4-4. Antennae rather short, not reaching to middle of 2nd segment when extended back; antennal articles smooth, somewhat compressed, the basal four mostly glabrous, the last three becoming increasingly setose; 2nd article largest; 4 terminal sensory cones. Eyes subtriangular, small, the interocular space about a third greater than largest diameter of an eye patch. Ocelli irregular in size and shape, about 40 in each cluster.

Collum of the usual spiroboloid form, the front edge set off by a marginal groove which extends up to the level of base of mandible. Entire surface smooth, sprinkled with very minute, widely separated punctures.

Pleurotergites of 2nd segment produced cephaloventrad into a conspicuous, strongly striate lobe projecting below and in front of the ends of the collum on each side.

Dorsal surface of segments with very shallow transversely oblong depressions on the midbelt, which is otherwise smooth and impunctate. Hindbelt slightly raised, smooth and shining, with a few tiny widely separated punctations. Transverse suture distinct across dorsum and down sides, passing behind the pores.

Preanal segment produced at the midline, forming a blunt subtriangular telson, much exceeded by the valves. Latter smooth, and polished, considerably swollen, meeting at a re-entrant angle, the free edges not set off by a submarginal groove. Preanal scale very broadly transverse, the width several times as great as the length.

Legs smooth, compressed, vestiture reduced to a single seta at the ventral end of each joint, except that the tarsal joints usually have from 3 to 6 macrosetae on the ventral side and another just above the insertion of the tarsal claw. Tarsal joints without velutinous pads. 1st and 2nd pairs of legs conspicuously smaller than those following. Prefemora of legs 4-7 compressed ventrad to form a rather acute edge but not excavated or otherwise modified. Coxal lobes of legs 3-7 not enlarged, consisting only of rudimentary blunt points.

Anterior gonopods very similar to those of *Narceus*, consisting of a V-shaped sternite, the coxites with mesially directed endite lobes, and

concave telopodites which partially envelop the posterior gonopods. Latter robust and hoodlike distally, their basal prefemoral process short and becoming terminally truncated and enlarged, less than half as long as telopodite. Coxae of posterior gonopods slender, fused with the spatulate coxal apodemes, connected only by the connective tissue surrounding the genitalia.

II.

The first description of a North American spiroboloid seems to be that of *Julus americanus* by Palisot Beauvois in 1805-1820, based upon a specimen doubtless taken along the eastern seaboard and probably at either Philadelphia or Charleston. This name was considered *inquirendum* by H. C. Wood in 1865, and was not rescued from oblivion until 1893, in a posthumously published paper by Charles H. Bollman.

Even more curious is the neglect of Rafinesque's 1820 names, which included the new genera and species *Narceus tinctorius* and *Rhexenor annularis*, both combinations being founded upon specimens of the composite "species" long known as *Spirobolus marginatus*. Rafinesque's descriptions mention size, color, segment number, minor structural details, and even an observation about the animal's defensive secretions. Although Rafinesque's contemporaries knew his work, and parts of it were cited by later workers, all apparently thought his only myriapod species was *Selista forceps*. In 1952 I accidentally discovered that Rafinesque had actually described six centipeds and four millipeds in *The Annals of Nature*, and the probable identity of these Rafinesquean species was considered by Dr. Crabill and me in 1953. *Rhexenor* and *Narceus* are generic synonyms, the latter having page priority, and *Narceus* is thus the oldest generic name proposed in what is now the order Spirobolida. Its type species, by monotypy, is *N. tinctorius*, based upon specimens from Kentucky. Since another of Rafinesque's diplopods was specified to have been found in the "knobby hills of Estill county, in Kentucky," I consider the same area suitable to serve as the restricted type locality. Specimens were obtained there in May 1954, and form the basis for the following redescription of the species.

Narceus tinctorius Rafinesque

Described from two male topotypes, RLH 6074, collected in the "Knobs" along State Hy. 80, about 5 miles southeast of Irvine, Estill Co., Kentucky, on May 9, 1954.

♂, 125mm long, 9.5mm wide, with 51 segments.

♂, 90mm long, 7.2mm wide, with 51 segments.

Color very dark slate gray, almost black, the caudal edges of the segments slightly tan, edges of the collum almost orange, antennae and legs reddish brown.

Body very stout, only about 13 times as long as wide.

Head convex, polished; epipharyngeal groove distinct as far up as lower edge of antennal sockets; genae not laterally margined, but with numerous fine ventrolaterally directed grooves. Labral setae 10-11 and 7-7, clypeal foveolae large and conspicuous, 5-5 and 6-5. Interantennal space with several fine transverse striae. Antennae moderately short, not reaching caudal margin of 2nd segment when extended back; articles smooth, compressed, the basal four glabrous, last three becoming increasingly pilose; 2nd article the largest, others except last slightly smaller

and subequal in size; 4 terminal sensory cones. Eyes suboval to reniform, large, interocular space about equal to greatest diameter of an eye patch. Ocelli very irregular in size and shape as well as number, 53-48 in one specimen and 38-42 in the other.

Collum of the usual spiroboloid form, its front edge with a distinct margining groove running from the tip up to about the middle of the eye patch. Entire surface, except marginal areas, finely and densely punctate, the punctures of the middorsal area tending to be joined by a network of fine grooves.

Pleurotergite of 2nd segment produced cephaloventrad into a conspicuous, strongly striate lobe projecting below and in front of the end of the collum.

Dorsal surface of segments densely punctate, the punctures finer on the midbelt and much coarser on the slightly raised and polished hind-belt. Transverse suture distinct across dorsum and down sides, passing behind the pores. Lower sides sculptured with about 20-25 striae of a flattened V shape, becoming more prominent ventrad.

Preal anal tergite forming a blunt subtriangular telson, much exceeded by the valves. Latter slightly convex basally, the swollen free margins set off by a shallow crescentic depression. Preal anal scale of the usual subtriangular shape.

Legs smooth and shining, vestiture reduced to a single seta at the ventral end of each joint (these missing entirely in the larger specimen) and usually two setae on the ventral side of the last joint. Ventral setae of the first pair of legs: 0-5-3-2-4-6; of the second: 0-1-3-2-4-(3)-5; of 3rd through 7th: 0-0-0-0-0-2. These formulas are constant in both specimens. Tarsal joints without pads. 1st leg pair not strongly reduced. Prefemora of legs 4-7 strongly compressed and excavated on the caudoventral surfaces. Coxal lobes of 3rd pair roughly pentagonal in shape, with the laterobasal side longest; coxal lobes of 4th-7th pairs slender, elongate cones, those of the 7th pair abruptly tapering distad from a swollen base.

Pleurites of 7th segment small, slender, mesially produced lobes which touch at a visible and distinct midventral suture. Anterior gonopods (fig. 4) of the usual spiroboloid type, composed of narrow transverse sternite (ST), coxites (CX) with mesially produced endite lobes (CXL), and strongly concave telopodites (TL), all three elements being connected by distal ramification of the coxal apodemes (CXA). Posterior gonopod (fig. 1) robust, with an elongated, lamellate prefemoral process which exceeds the end of the tibiotarsal portion.

III.

Numerous species, clearly congeneric with *tinctorius*, have been described from eastern United States. The existing literature descriptions are entirely inadequate for evaluation of these names, and a satisfactory settlement must await a thorough revision of the genus. On the basis of material already assembled toward this end, I am inclined to believe that most of the named forms will prove to be but geographic races, whose definition will have to depend upon more subtle characters than hitherto employed. For the purposes of this paper, it will be sufficient merely to point out the distinction between the Chinese and American genera which have previously shared the name *Spirobolus*.

Selecting the structural peculiarities, which, when taken in combination, appear to warrant the recognition of two distinct genera, we can arrive at the following brief differentiating couplet. Of Chinese forms I have seen material of what appears to be Pocock's *S. walkeri*, in addition to the series of *bungii*, and include here an illustration of the posterior gonopod in this species.

1. Prefemoral process of posterior gonopods short, less than half as long as telopodite; anal valves swollen and meeting at a moderate re-entrant angle, completely lacking margins on the free edges; tergites smooth with very tiny, scattered punctuations; anterior coxae of males without modified lobes..... *Spirobolus* Brandt
 Prefemoral process of posterior gonopods extending distad as far as end of telopodite; anal valves less swollen and with definite raised mesial margins; tergites coriaceous or slightly rugose, usually with very pronounced punctuation; anterior coxae of males with variously modified coxal lobes..... *Narceus* Rafinesque

NOMENCLATORIAL CONSIDERATIONS

The two genera under discussion may be summarized with respect to their nomenclatorial status, as follows:

Spirobolus Brandt

Spirobolus Brandt, 1833, Bull. soc. nat. Moscou, vol. 6, p. 203.—Pocock, 1893, Journ. Linnean Soc. London, Zool., vol. 24, p. 484.—Brolemann, 1914, Ann. soc. ent. France, vol. 83, p. 31.

Prospirobolus Attems, 1910, in: Voeltzkow's Reise Ostafrika, vol. 3, p. 90 (type, *Spirobolus joannisi* Brolemann, 1896).

Sinobolus Chamberlin and Wang, 1953, Amer. Mus. Nov., no. 1621, p. 12 (type, *Spirobolus joannisi* Brolemann 1896).

Type species.—*Spirobolus bungii* Brandt 1833, by subsequent designation of Pocock, 1894.

Synonymy.—The authors of *Sinobolus* erected the genus with the following characterization:

“Posterior gonopods lacking the free inner piece present, e.g., in the American *Narceus* Raf. (= *Spirobolus* as restricted by Brolemann). This perhaps represented by a transverse arm projecting mesad from base of gonopod proper. This arm with short angle or process projecting distad from its free end, while from its basal end a spine or curved finger-like process projects, lying against the base of the gonopod proper. Median plate of anterior gonopods absent or abortive.

“Generotype: *Spirobolus joannisi* [sic] Brolemann.”

It will be noted that Chamberlin and Wang detected the outstanding difference between *joannisi* and the American species, although I fail to understand why comparison was made only with *Narceus* while the legitimate claims of Brandt's *Spirobolus* to be considered were quite disregarded. Nor do I entirely understand the statement that the sternite of the anterior gonopods is absent or abortive. Brolemann's figure shows a well-developed sternite.

However, since *joannisi* is pretty clearly congeneric with *bungii*, consideration of *Sinobolus* is not necessary. Even if Brandt's type should be found, and *bungii* shown to be generically different from my present concept of it, there remains the much older name *Prospirobolus* Attems for *joannisi* and its close relatives.

Narceus Rafinesque

Narceus Rafinesque, 1820, *Annals of Nature*, vol. 1, p. 9.—Hoffman and Crabill, 1953, *Florida Entom.*, vol. 36, p. 80.

Rhexenor Rafinesque, 1820, *Annals of Nature*, vol. 1, p. 9 (type: *R. annularis* Rafinesque [= *Narceus annularis* (Rafinesque)], by monotypy).—Hoffman and Crabill, 1953, *Florida Entom.*, vol. 36, p. 81.

Spirobolus (*nec* Brandt) Wood, 1865, *Trans. American Philos. Soc.*, vol. 13, p. 207.—Bollman, 1893, *Bull. U. S. Nat. Mus.* No. 46, p. 145.—Chamberlin, 1947, *Proc. Acad. Nat. Sci. Philadelphia*, vol. 99, p. 44.

Arctobolus Cook, 1904, *Harriman Alaska Exped.*, vol. 8, p. 64 (type: *A. onandaga* Cook [= *Narceus annularis* Rafinesque], by original designation).

Type species.—*Narceus tinctorius* Rafinesque, by monotypy.

Synonymy.—Both *Rhexenor* and *Arctobolus* are junior subjective synonyms of *Narceus*, based upon specimens from New York State which are apparently conspecific. Had the Rafinesque names not been available, *Arctobolus* would be the correct generic name for the American forms, as maintained by Cook, and following him, by Loomis in numerous papers.

The status of the species of *Narceus* remains badly confused, and final resolution of the problem will depend upon a careful monographic study of the genus.

ACKNOWLEDGEMENTS

I wish to indicate my indebtedness to Drs. Howard E. Evans and John G. Franclemont of the Department of Entomology, Cornell University, who kindly read the manuscript of this paper in its early stages and made several valuable suggestions for its improvement. Dr. Edward A. Chapin, former curator of the Division of Insects, United States National Museum, generously loaned the Chinese specimens which made the project possible.

EXPLANATION OF FIGURES

Fig. 1. *Narceus tinctorius* Rafinesque, caudomesial aspect of left posterior gonopod, from topotype, 5 miles east of Irvine, Estill County, Kentucky.

Fig. 2. *Spirobolus walkeri* Pocock, caudomesial aspect of left posterior gonopod, specimen from Hangkow, China (O. F. Cook and H. F. Loomis, colls.).

Fig. 3. *Spirobolus bungii* Brandt, caudomesial aspect of left posterior gonopod, specimen from 65 miles north of Peking, China (A. deC. Sowerby, coll.).

Fig. 4. *Narceus tinctorius*, anterior gonopods, anterior aspect on the left, posterior on the right. Drawn from a cleared mount, the coxal sutures distinct.

Fig. 5. *Spirobolus bungii*, anterior gonopods, anterior aspect. Coxae and coxal apodemes slightly separated from sternite during dissection of the specimen, normally much as in *Narceus*.

Abbreviations: CX: coxite; CXA: coxal apodeme; CXL: coxal endite lobe; S: Sternite; TL: telopodite; PF: prefemoral process of posterior gonopod.